Attachment DAT to the Memorandum of Understanding LIGO-M050280-00 between the Australian Consortium for Interferometric Gravitational Astronomy (ACIGA) and the Laser Interferometer Gravitational Wave Observatory (LIGO)

For The Period August 15, 2008 - August 14, 2009

This Attachment DAT to the Memorandum of Understanding LIGO-M050280-00 defines the role of the Australian Consortium for Interferometric Gravitational Astronomy (ACIGA) as a Member of the LIGO Scientific Collaboration (LSC). In particular, it addresses data analysis activitites in support of the initial LIGO interferometers. The period of performance for the activities in this Attachment is from August 15, 2008 - August 14, 2009.

1. Collaboration

Together, the LIGO Laboratory and the LIGO Scientific Collaboration (LSC) are responsible for implementing and exploiting the initial LIGO detector through its science data runs. The LSC has organized the data analysis effort into search groups which coordinate analysis, review, and publication on behalf of the collaboration. LSC groups are encouraged to participate in one or more of these groups.
MOU Attachment DAT defines the contributions of each participating group to the data analysis development groups.

2. Participation

During the period August 15, 2008 - August 14, 2009, the members of ACIGA will participate in the analysis of initial LIGO data in the following areas:

a. Binary Inspirals

UWA/Caltech
Wen(UWA/Caltech)
Linqing Wen is going to work with UWA researchers and student and the Caltech LIGO group to develop GPU-accelerated search pipelines using the data-parallelism of the GPUs.

b. Bursts

ANU
During this period we will become active members of the LOOC UP (Locating

and Observing Optical Counterparts to Unmodeled Pulses in Gravitational Waves) project, with our particular focus being the Skymapper project. The Skymapper telescope is currently on its way to Australia and will start commissioning at the end of September. In the 12 months leading up to Aug09 we will set-up the pipeline necessary to follow-up real-time LIGO-Virgo gw "events" with Skymapper. The pipeline will also need to be thoroughly tested during that time in preparation for the three-site network data taking expected to occur from around mid 2009. Scott and PhD student Sattherthwaite are requesting to join the Burst group.

CSU

Detecting chirping signals in coloured noise.

The papers [1,2] covers the case where the support of the signal is known ie. when we have a segment of noisy data that is approximately the same length in time as the signal, and we wish to determine if there is a signal present or not. The aim for the period 2008-2009 is to produce a data analysis pipeline in Matlab to apply the method to LIGO data based on the example of the q-pipeline.

[1] E J Candes, P R Charlton and H Helgason, "Detecting highly oscillatory signals by chirplet path pursuit" Applied and Computational Harmonic Analysis, in press, available online 4 May 2007.

[2] E J Candes, P R Charlton and H Helgason, "Gravitational wave detection using multiscale chirplets" Classical and Quantum Gravity, to appear (accepted June 30 2008), arXiv:0806.4417v2 [gr-qc]. LIGO Technical Document P080017-00-Z.

UWA

Coward (UWA), Howell (UWA), Imerito (UWA), Regimbau (VIRGO/LIGO)

Zadko Telescope optical follow-up of LIGO/VIRGO burst candidates

The UWA team, led by Coward, have engaged with the burst group to initiate plans for an MOU as part of the LIGO LOOC UP program. The UWA Zadko Telescope, is a 1m fast response telescope that is being enabled for remote and robotic observations and is the only suitable telescope for deep optical follow-ups of GW signals at 130o longtitude. It has a FOV of about $\frac{1}{2}$ degree (to be increased to 1 degrees in 2010) and a limiting magnitude m ¿ 21. Commissioning commenced in Jan 2009 and it is currently enabled for transient searches and performing following-up of GRBs. During early commissioning, two GRB afterglows have been imaged using the Zadko Telescope and reported via GCN circulars.

The Zadko Telescope Team is collaborating with the TAROT robotic telescope team to establish a network of robotic telescopes in France, Chile and Western Australia. The Zadko project is currently being included into the TAROT MOU with LIGO. TAROT will be working closely with Zadko to install a robotic system compatible with TAROT. We note that SkyMapper, located in eastern Australia, will extend and complement the potential role of this network in relation to GW triggered follow-ups.

Work plan 1. The project will enable the Telescope for remote access and control in April 2009. Communications hardware and software will be installed and tested by August 2009 to enable interrupts from external sources to initiate rapid response pointing and imaging. The project will test the communications using

GCN alerts. To maximize the science opportunities the team will initiate a pilot study in 2009 using the Zadko Telescope for (initially) late optical follow-ups (1-2 days) of simulated LIGO/VIRGO triple coincidence triggered bursts. Late follow-ups on this time-scale are optimal for the optical emission expected form core collapse supernovae. Initial tests will employ simulated burst triggers sent to refine data acquisition and imaging techniques and to establish the optimal method for data transfer. The second stage will employ LIGO science data for optical follow-ups, assuming that the communications protocols are in place.

Stage 1 will not require LIGO data products but will require information on the error boxes of the simulated sky positions of the bursts. This can be acquired from the burst group. Stage 2 will require S6 candidate burst sky coordinates to perform late-time optical follow-ups.

Modelling Critical for the optical follow-up of GW bursts candidates is the localisation of a possible coincident optical transient and the expected rate of un-triggered transients out to the detection horizon of LIGO. The latter depends very strongly on the magnitude limit of the telescope, the brightness distribution of the transients, the intrinsic rate of the transient, the temporal decay of the afterglow (for GRBs) and the response time of the telescope. The rate of observable transients per sky area for a particular telescope can be used to estimate the probability of a false coincident detection for the same telescope. Coward and Regimbau will be working with the TAROT team to constrain the non-coincident optical transient rates potentially observable by TAROT and Zadko.

Work plan 2. The team will investigate the untriggered or non-coincident rate of observable optical supernova and GRB optical afterglows.

The work will be actioned by Regimbau (VIRGO) and Coward (UWA) and will commence in mid 2009. The work will be reported to the Burst group and/or the LOOC UP program and the results will be published as part of a Zadko commissioning paper.

No LIGO data products are required.

UWA/Caltech

Wen(UWA/Caltech)

Linqing Wen is going to collaborate with Yanbei Chen and other Caltech PMA members to further investigate the angular resolutions of a network of GW detectors and its efficiency in identifying electromagnetic counterparts of GW events.

c. Stochastic

Not Applicable

d. Continuous

Within ACIGA, there are a number of activities related to continuous wave sources. Research is being carried out at ANU,and by new members from the astrophysics community at the University of Melbourne and Monash University. The program is overseen by Dr Scott (ANU) and with Prof Ben Owen (PSU) helping to link the programs together.

ANU

Searches for isolated neutron stars (ANU) (with Ben Owen, PSU)

CasA: It is expected that the search will begin formal review by the CW Working Group reviewers by August 2008, that the search will completed by November 2008 and that a draft of the paper detailing the results will be circulated to the LSC in early 2009.

Univ. of Melbourne (A. Melatos)
The group will extend last years program to gradually build up computing infrastructure and expertise. In parallel, it will involve itself in two related continuous wave searches.
1. Write how-to guides for relevant components of the LAL and LALApps software suites as they are used by the group, in order to consolidate local expertise and build up a library of practical introductory materials for incoming PhD students.
2. In collaboration with Krishnan (AEI) and Papa (AEI), generalise the radiometer code to also search over spin frequency derivative. Revalidate.
3. Run the radiometer search on S5 data.
4. In collaboration with Owen (Penn State), prepare a comb-over search for Sco X-1 (which is believed to be driven toward its indirect limit, unlike pulsars). The search will employ Ransoms frequency comb method, studied in a technical paper by Messenger & Woan (2007), over a wide frequency band. The first step involves a manuscript firming up estimates of sensitivity versus computational cost for realistic conditions and comparing to astrophysical emission scenarios. The second step is to adapt exisiting F-statistic code for the search.
5. Transfer a scientifically useful subset of the S5 data to local storage to support the above searches on a local teraflop cluster (VPAC).
At present, the University of Melbourne group has zero discretionary funding. It is therefore unable to commit to any LIGO activities incurring direct expenses, such as travel to LIGO sites/meetings. This unavoidable constraint has been communicated to the leadership of ACIGA and the LSC Continuous Wave Search Group, as well as the collaborators named in the data analysis program above.

Monash University (D. Galloway)
Searches for accreting neutron stars
Wish to continue a 'watching brief' with a view to submitting a research plan in August 2009.

e. Other Contributions

Not Applicable

3. Resource Sharing

The LIGO Laboratory will contribute resources including allocation of appropriate scientific and engineering personnel, research facilities, and funding in support of the effort in Item No. 2, as indicated below.

a. Research accommodations for ACIGA group members while on LIGO research assignment at any LIGO Laboratory site.

Research accommodations for ACIGA group members while on LIGO research assignment at any LIGO Laboratory site.

b. Access to LIGO data through established LSC channels in support of this work.

Access to LIGO data through established LSC channels in support of this work.

4. Coordination and Reporting

ACIGA will perform research within the structures established by the LIGO Laboratory and the LSC where appropriate.
In particular, with reference to activities described above:

2a will be carried out within the LSC Inspiral Search Group.

2b will be carried out within the LSC Burst Search Group.

2c will be carried out within the LSC Stochastic Search Group.

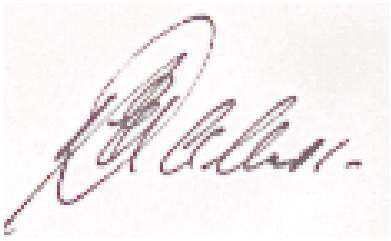
2d will be carried out within the LSC Continuous Waves search Group.

This includes keeping the Group leaders informed of activities and plans, reporting to the group at meetings and telecons, and through technical documents submitted to the LIGO Document Control Center.
In addition, an annual report will be submitted with the update to this Attachment, giving a summary status on research by topic as indicated in Item No. 2, including progress against the milestones if any, significant accomplishments such as new insights/discoveries or publications, issues of concern if any, and an indication of invested time.
This Attachment will be updated at least annually with a plan of activities for the succeeding one-year period. These documents will be due one month before the close of the period of performance under this Attachment.

5. Computer Code

All computer code delivered to the LSC under this Attachment must be developed in consultation with the LSC Data Analysis Software Working Group (DASWG) and archived, documented and reviewed as determined by that group.

Jay Marx
LIGO Laboratory Director



David Ernest McClelland
Principal Investigator(s)
ACIGA

David Reitze
LSC Spokesperson